INTERNATIONAL SOLDIER SYSTEMS CONFERENCE AND EXHIBITION 2004

Interactive Textiles for Soldier Systems

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The Science Behind the Warrior: Yesterday, Today and

Interactive Textiles for Soldier Systems Presentation Outline

- What is an Interactive Textile?
- The modern battlefield
- Interactive Textiles on the future battlefield.
- Army R&D program
- Technical challenges
- Marketplace prospects
- Summary

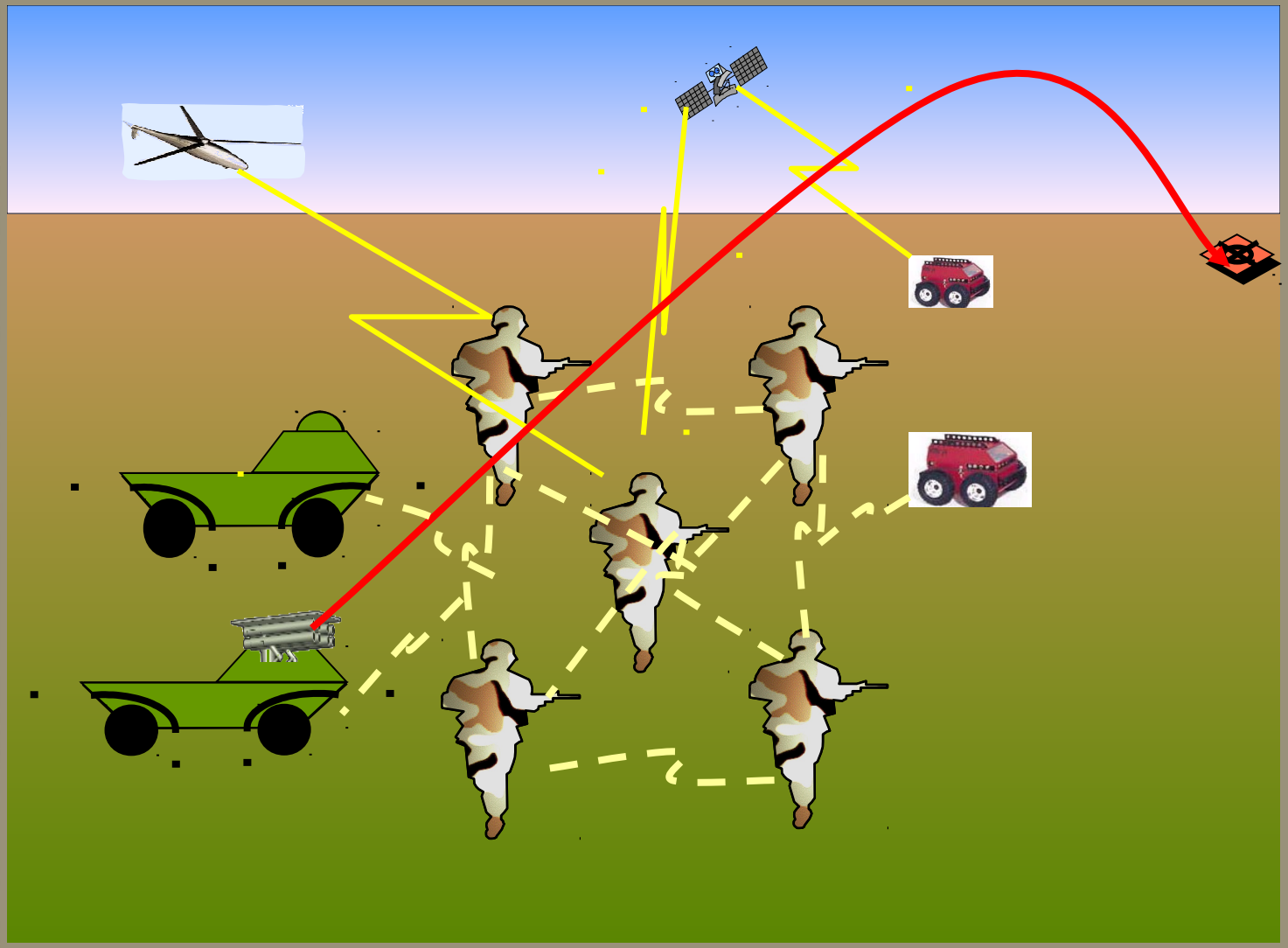
Definition of an Interactive Textile

A Textile that exhibits at least one unique and valuable property that "intelligently" responds to a stimulus. These materials could have the ability to sense and react (e.g., color change, oscillate, swell), conduct electricity, perform computational operations, and/or collect/store energy.

Modern Warfighting Scenarios and Environments

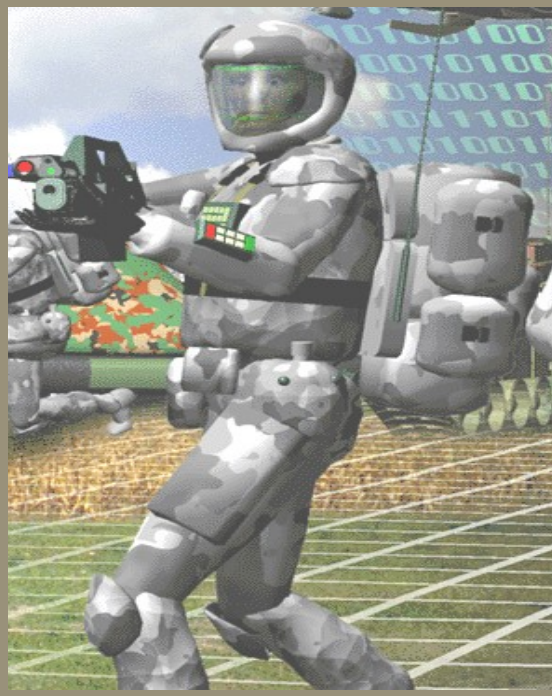
- Terrorism – domestic and foreign
- Peace keeping
- Nation building
- Low intensity conflicts
- High intensity conflicts
- Special operations
- Military Operations in Urban Terrain
- Worldwide climatic extremes

Network Centric Joint Warfare Concept



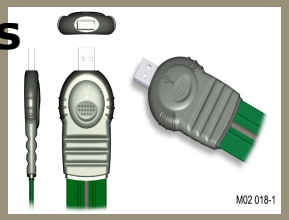
Interactive Textiles on the Future Battlefield

- Physiological status monitoring
- Sensing of battlefield hazards
- Battlefield surveillance
- Mobility enhancement
- Threat responsive protection
- Combat ID
- Real time communication
- Lightweight, low cube power generation



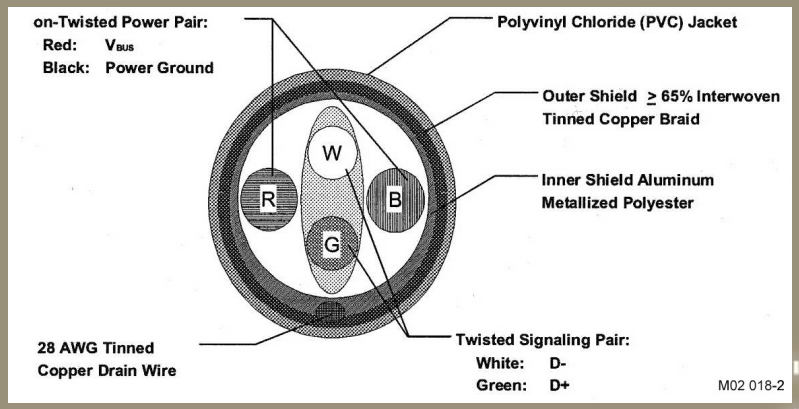
Natick Soldier Center (NSC) R&D Project Areas in Interactive Textiles

- Electro-Optic fabrics
- Optical and electrical sensor embedding & connection techniques
- Wearable sensor embedding techniques
- Prototyping of novel textile cables
- Development of wearable connectors for U
- Soldier wearable antennas
- Self-decontaminating barrier fabrics
- Interactive Textiles for variable glide aerial delivery parachutes
- Electro-optic stitchless seam technol
- Body conformal cables and connector
- Combat uniform fabric keypad
- Photovoltaic Energy Harvesting Fabrics
- Flexible Displays



Electro-Textiles for Future Soldier Systems Personal Area Network

- Provides power and data transport
- Narrow fabrics manufacturing technology
- COTS materials
- Durable, launderable
- Low cost
- Flat, flexible, lightweight
- Eliminates “snag” hazard
- “Mature” technology vs wireless PAN
- Redundancy or “back-up” to wireless



NSC Ongoing R&D in Interactive Textiles

- **Program:**
  - Electrotextiles: Self-Powered, Conductive and Smart
- **Projects**
  - Novel Conductive Fibers for Multi-Path Power/Data Transfer Embedded in Textile Substrates of Warrior Clothing & Equipment
  - Computer Input Devices & Embedded Sensors in Future Warrior Handwear
  - Shelter Fabric and Soldier Uniform Textile-Mounted Electronic Displays for Military Command Functions

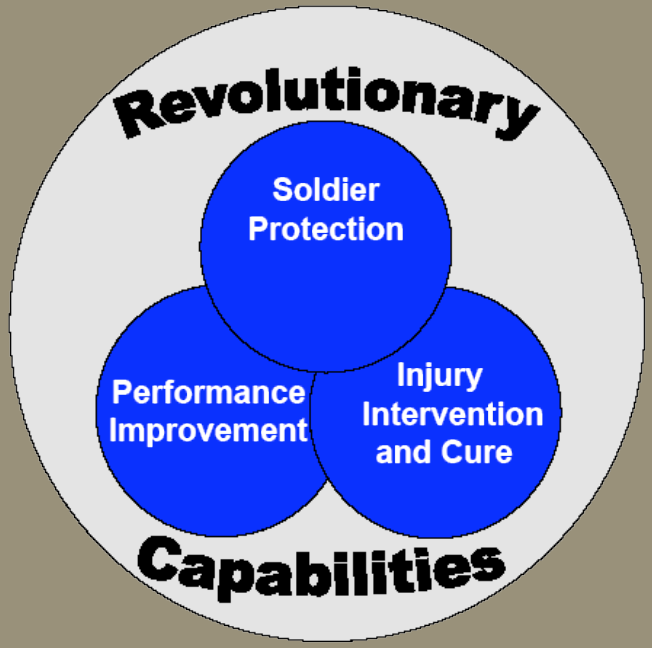
NSC Ongoing R&D in Interactive Textiles

Projects (con't)

- Shelter Fabric and Soldier Uniform Textile-Mounted Electronic Displays for Military Command Functions
- Electro-Textile Snap Style Connector.
- Soldier Conformal VHF/UHF Antenna Suite, Squad, Soldier, & GPS.
- Effects of Carbon Nanotubes on Antenna WSWR & Signal Strength.
- Fastex Style Connector.

Army Research Office (ARO) Institute for Soldier Nanotechnologies (ISN)

- Army's key nanoscience resource
- Fundamental research for the soldier
- MIT and industrial partners
- Long term investment
- 46 Projects, 37 faculty, 122 students
- On-site Army and industrial researchers
- Unique management by ARO and Capability Area Review Teams



ARO-ISN Projects Relevant to Interactive Textiles

- **Mechanically active materials and devices**
  - Nanostructured polymer actuators.
  - Optimization of conducting polymer actuators.
  - LC thermoplastic elastomers for actuator and electromechanical applications.
  - Chemically switchable magnetic materials for actuators.
  - Model-based control of mechanically active materials.

- **Sensors and Counteraction**
  - Viral/Peptide array sensing systems.
  - Active/Passive cylindrical photonic crystal systems.
  - Dendrimer/Nanoparticle assemblies as chemical toxin deactivation coatings.
  - Block co-polymer based conjugated polymer sensing system.

ARO-ISN Projects Relevant to Interactive Textiles

- **Sensors and Counteraction (con't)**
  - High sensitivity sensors based on conducting and semi conducting organic molecules and polymers.
  - IR detection systems for optical sensing.
  - Microbiocidal, antiviral, and antisporal fabrics and other materials.

- **Biomaterials and Nanodevices for Soldier Medical Technology**
  - Switchable surfaces.
  - Semi-active variable impedance materials: Biomech. design & control.
  - Field responsive fluids for load transfer in splints & other medical devices

ARO-ISN Projects Relevant to Interactive Textiles

- **Systems and Technology Transitioning**
  - Battlesuit system architectures for optimal use of nanotechnologies.

- **Processing and Characterization - The Nanofoundaries**
  - Processing of fibers and fibrous materials.
  - Chemical vapor deposition polymers for Soldier suit interconnection.
  - Three-dimensional integration of microfluidic devices and fiber networks.
  - Low pressure material deposition by misted solution transport.
  - Nanoscale multilayer films: processing, properties, & morphology.

Technical Challenges in the Development of Interactive Textiles

- Cost
- Producibility
- Durability
- Human factors
- Safety
- Component integration

Interactive Textiles Applications Expected in the Marketplace within this Decade

- **Motion, pressure, CB, & physiological status sensors embedded in fabrics.**
- **Acoustic arrays in large area textiles.**
- **Flexible antenna arrays in garments.**
- **Body heat-generated power: self-heated clothing.**
- **Durable printed displays.**
- **Fabric-based batteries.**
- **RFID technology in apparel tags for item tracking and inventory management.**

Summary

- **Network Centric Warfare operations will be essential to fighting effectively on modern battlefields.**
- **Interactive textiles and their supporting technologies will be an enabler of Network Centric Warfare.**
- **NSC and ARO are leaders in the research and development of novel interactive textiles for the warrior.**
- **Interactive textiles are projected within five years to generate a total of $720M in annual sales revenue.**
- **The climate for cooperative R&D in interactive textiles is currently very favorable.**